CAN SHELL AND DOUBLE-SEAMED CAN END

Related Application

This application is a continuation-in-part of application Serial No. 10/361,245, filed February 10, 2003, which is a continuation-in-part of Serial No. 10/078,152, filed February 19, 2002, Patent No. 6,516,968, which is a continuation-in-part of application Serial No. 09/898,802, filed July 3, 2001, Patent No. 6,419,110.

Background of the Invention

[0001] This invention relates to the construction or forming of a sheet metal or aluminum can shell and can end having a peripheral rim or crown which is double-seamed to the upper edge portion of a sheet metal or aluminum can body. Such a can end is formed from a drawn sheet metal can shell, for example, a shell produced by tooling as disclosed in U.S. Patent No. 5,857,374 which issued to applicant. Commonly, the formed can shell includes a circular center panel which extends to a panel wall which extends to or also forms the inner wall of a reinforcing rib or countersink having a U-shaped cross-sectional configuration. The countersink is connected by a frusto-conical chuckwall to an annular crown which is formed with a peripheral curl. For beverage containers, the center panel of the shell is commonly provided with an E-Z open tab, and after the can body is filled with a beverage, the peripherally curled crown of the shell is double-seamed to the upper end portion of the can body.

[0002] When the can body is filled with a carbonated beverage or a beverage which must be pasturized at a high temperature, it is essential for the can end to have a substantial buckle strength to withstand the pressurized beverage, for example, a buckle strength of at least 90 psi. Such resistance to "buckle" pressure and "rock" pressure is described in detail in U.S. Patent No. 4,448,322, the disclosure of which is incorporated by reference. It is also desirable to minimize the weight of sheet metal or aluminum within the can end without reducing the buckle strength. This is accomplished by either reducing the thickness or gage of the flat sheet metal from which the can shell is drawn and formed and/or by reducing the diameter of the circular blank cut from the sheet metal to form the can shell.

[0003] There have been many sheet metal shells and can ends constructed or proposed for increasing the buckle strength of the can end and/or reducing the weight of sheet metal within the can end without reducing the buckle strength. For example, U.S. Patents No. 3,843,014, No. 4,031,837, No. 4,093,102, above-mentioned No. 4,448,322, No. 4,790,705, No. 4,808,052, No. 5,046,637, No. 5,527,143, No. 5,685,189, No. 6,065,634, No. 6,089,072, No. 6,102,243, No. 6,460,723 and No. 6,499,622 disclose various forms and configurations of can shells and can ends and the various dimensions and configurations which have been proposed or used for increasing the buckle strength of a can end and/or reducing the metal in the can end. Also, published PCT application No. WO 98/34743 discloses a modification of the can shell and can end disclosed in above-mentioned Patent No. 6,065,634. In addition to increasing the buckle strength/weight ratio of a can end, it is desirable to form the can shell so that there is minimal modifications required to the extensive tooling existing in the field for adding the E-Z open tabs to the can shells and for double-seaming the can shells to the can bodies. While some of the can shells and can ends disclosed in the above patents provide some of desirable structural features, none of the patents provide all of the features.

Summary of the Invention

[0004] The present invention is directed to an improved sheet metal shell and can end and a method of forming the can end which provides the desirable features and advantages mentioned above, including a significant reduction in the blank diameter for forming a can shell and a significant increase in strength/weight ratio of the resulting can end. A can shell and can end formed in accordance with the invention not only increases the buckle strength of the can end but also minimizes the changes or modifications in the existing tooling for adding E-Z open tabs to the can shells and for double-seaming the can shells to the can bodies.

[0005] In accordance with one embodiment of the invention, the can shell and can end are formed with an overall height between the crown and the countersink of less than .240 inch and preferably less than .230 inch, and the countersink has a generally cylindrical outer wall and an inner wall connected to a curved panel wall. A generally frusto-conical chuckwall extends from the outer wall of the countersink to the inner wall of the crown and has an upper wall portion extending at an angle of at least 16° relative to the center axis of the

shell, and preferably between 25° and 30°. The countersink may have a generally flat bottom wall or inclined inner wall which connects with the countersink outer wall with a small radius substantially less than the radial width of the bottom wall, and the inside width of the countersink at its bottom is less than the radius of the panel wall.

[0006] In accordance with modifications of the invention, a can shell and can end have some of the above structure and with the junction of a lower wall portion of the chuckwall and the outer countersink wall being substantially below the center panel. The lower wall portion of the countersink extends at an angle less than the angle of the upper wall portion relative to the center axis and is connected to the upper wall portion by curved wall portions which provide the chuckwall with a slight S-curved configuration. The countersink has a radius of curvature substantially smaller than the radius of curvature of the curved panel wall, and the inner width of the countersink is also less than the radius of the panel wall, and preferably less than .035 inch.

[0007] Other features and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

Brief Description of the Drawings

[0008] FIG. 1 is a vertical cross-section through a sheet metal can shell formed in accordance with the invention;

[0009] FIG. 2 is an enlarged fragmentary section of the can shell in FIG. 1 and showing the configuration of one embodiment;

[0010] FIG. 3 is a smaller fragmentary section of the can shell of FIG. 2 and showing the can shell becoming a can end with a double-seaming chuck and a first stage roller;

[0011] FIG. 4 is a fragmentary section similar to FIG. 3 and showing a double-seamed can end with the chuck and a second stage roller;

[0012] FIG. 5 is an enlarged fragmentary section of the double-seamed can end shown in FIG. 4 and with a fragment of the modified double-seaming chuck;

[0013] FIG. 6 is a section similar to FIG. 1 and showing a double-seamed can end formed in accordance with the invention;

[0014] FIG. 7 is an enlarged fragmentary section similar to FIG. 2 and showing a can shell formed in accordance with a modification of the invention;

[0015] FIG. 8 is an enlarged fragmentary section similar to FIG. 5 and showing the can shell of FIG. 7 double-seamed onto a can body;

[0016] FIG. 9 is an enlarged fragmentary section similar to FIG.7 and showing a can shell formed in accordance with another modification of the invention;

[0017] FIG. 10 illustrates the stacking and nesting of can shells formed as shown in FIG. 9;

[0018] FIG. 11 is an enlarged fragmentary section of the chuckwall of the can shell shown in FIG. 9, and

[0019] FIG. 12 is an enlarged fragmentary section similar to FIG. 9 and showing a can shell formed in accordance with another modification of the invention.

Description of the Preferred Embodiments

[0020] FIG. 1 illustrates a one-piece shell 10 which is formed from a substantially circular blank of sheet metal or aluminum, preferably having a thickness of about .0085 inch and a blank diameter of about 2.705 inches. The shell 10 has a center axis 11 and includes a slightly crowned center panel 12 with an annular portion 14 extending to a curved panel wall 16. The center panel wall portion 14 and panel wall 16 may be formed by a series of blended curved walls having radii wherein R1 is 1.489 inch, R2 is .321 inch, R3 is .031 inch, and R4 is .055 inch. The curved panel wall 16 has a bottom inner diameter D1 of about 1.855 inch.

[0021] The curved panel wall 16 with the radius R4 extends from an inner wall 17 of a reinforcing rib or countersink 18 having a U-shaped cross-sectional configuration and including a flat annular bottom wall 22 and a generally cylindrical outer wall 24 having an inner diameter D2, for example, of about 1.957 inches. The flat bottom wall 22 of the countersink 18 is connected to the inner panel wall 16 and the outer countersink wall 24 by curved corner walls 26 each having an inner radius R5 of about .010 inch. The radial width W of the flat bottom wall 22 is preferably about .022 inch so that the inner bottom width W1 of the countersink 18 is about .042 inch.

[0022] The outer wall 24 of the countersink 18 connects with a generally frusto-conical chuckwall 32 by a curved wall 34 having a radius R6 of about .054

inch. The chuckwall 32 extends at an angle A1 of at least 16° with respect to the center axis 11 or a vertical reference line 36 which is parallel to the center axis 11 of the shell. Preferably, the angle A1 is between 25° and 30° and on the order of 29°. The upper end of the chuckwall 32 connects with the bottom of a curved inner wall 38 of a rounded crown 42 having a curled outer wall 44. Preferably, the inner wall 38 of the crown 42 has a radius R7 of about .070 inch, the inner diameter D3 at the bottom of the curved inner wall 38 is about 2.039 inch, and the outer diameter D4 of the curled outer wall 44 is about 2.340 inches. The height C of the curled outer wall 44 is within the range of .075 inch and .095 inch and is preferably about .079 inch. The depth D from the bottom of the outer curled wall 44 or the junction 46 of the chuckwall 32 and the inner crown wall 38 to the inner surface of the countersink bottom wall 22 is within the range between .108 inch and .148 inch, and preferably about .126 inch. The junction 47 or the center point for the radius R6 has a depth G of about .079 from the junction 46 or bottom of the curled outer wall 44 of the crown 42.

[0023] FIG. 3 shows the crown 42 of the shell 10 being double-seamed onto an upper peripheral end portion 48 of a sheet metal or aluminum can body 50. The double-seaming operation is performed between a rotating double-seaming circular chuck 55 which engages the shell 10 and has an outer surface 58 which may be slightly tapered between an angle of 0° and 10° with respect to the center axis of the chuck 55 and the common center axis 11 of the shell 10. Preferably, the surface 58 has a slight taper of about 4° and is engaged by the inner wall 38 of the crown 42 in response to radially inward movement of a first stage double-seaming roller 60 while the can body 50 and its contents and the shell 10 are rotating or spinning with the chuck 55. The chuck 55 also has a frusto-conical surface 62 which mates with and engages the frusto-conical chuckwall 32 of the shell 10, and a downwardly projecting annular lip portion 64 of the chuck 55 extends into the countersink 18 and has a bottom surface 66 (FIG. 5) and a cylindrical outer surface 68 which engage the bottom wall 22 and the outer wall 24 of the countersink 18, respectively.

[0024] FIGS. 4 & 5 illustrates the completion of the double-seaming operation to form a double-seamed crown 70 between the rotating chuck 55 and a second stage double-seaming roller 72 which also moves radially inwardly while the chuck 55, shell 10 and can body 50 are spinning to convert the shell 10 into a can end 75 which is positively attached and sealed to the upper end portion 48 of the can body 50. The double-seamed rim or crown 70 has an inner

wall 74 which is formed from the inner wall 38 of the shell crown 42 and also has an outer wall 76 formed from the shell crown 42 including the outer curled wall 44. The double-seamed crown 70 has a height H2 within the range between .090 inch and .110 inch and preferably about .100 inch. The can end 75 has an overall height H1 between the top of the crown 70 and the bottom of the countersink 18 within the range of .170 inch and .240 inch, and preferably about .235 inch. Since the can end 75 has the same cross-sectional configuration as the shell 10 with the exception of the double-seamed crown 70, the same common reference numbers are used in FIGS. 4-6 for the common structure.

[0025] As apparent from FIG. 6, the center portion of the center panel 12 defines a plane 80 which substantially intersects the junction 46 of the chuckwall 32 with the inner wall 74 of the double-seamed crown 70. The E-Z open tab has been omitted from FIG. 6 for purposes of clarity and simplification and since the E-Z open tab forms no part of the present invention.

[0026] FIGS. 7 & 8 show another embodiment or modification of the invention including a can shell (FIG. 7) and a double-seamed can end (FIG. 8). Accordingly, the structural components corresponding to the components described above in connection with FIGS. 1-6, have the same reference numbers but with the addition of prime marks. Thus referring to FIG. 7, a can shell 10' has a center axis which is the same as the axis 11 and includes a circular center panel 12' connected to a peripheral curved panel wall 16' which connects with an inclined inner wall 17' of a countersink 18' having a U-shaped cross-sectional configuration. The countersink has a generally cylindrical outer wall 24' which extends at an angle less than 10° and connects with a chuckwall having a frusto-conical upper wall portion 32' and a slightly curved lower wall portion 34'. The wall portions 32' and 34' are connected by a kick or generally vertical short riser portion 35' having relatively sharp inside and outside radii, for example, on the order of .020 inch. The upper chuckwall portion 32' is connected by a curved wall 37' to the inner curved wall 38' of a crown 42' having a curved outer wall 44'.

[0027] The inner wall 38' of the crown 42' connects with the upper chuckwall portion 32' at a junction 46', and the outer wall 24' of the countersink 18' connects with the lower chuckwall portion 34' at a junction 47'. The vertical height G1 from the bottom of the countersink 18' to the kick or riser portion 35' is about .086. The radius R10 is about .051 inch, and the lower wall portion 34' extends at an angle A3 of about 15°. The countersink 18' has a radius R9 of

about .009 to .011 inch. Other approximate dimensions and angles for the shell 10' shown in FIG. 7 are as follows:

C1	.082 inch	W1	.024 inch		
C2	.153 "	W2	.063 "	H5	.078 inch
D6	1.910 "	W3	.034 "	H6	.149 "
D7	2.036 "	A2	.29°		
D8	2.337 "	A3	15°		
D9	1.731 "	A4	16°		
		A6	13°		

[0028] The particular cross-sectional configuration of the can shell 10' has been found to provide performance results superior to the performance results provided by the can shell 10. Accordingly, the details of the configuration of the can shell 10' include a chuckwall upper wall portion 32' having an angle A2 relative to the center axis of at least 16° and preferably within the range of 25° to 30°. The lower wall portion 34' of the chuckwall forms an angle A3 which is about 15°. The inner wall 38' of the crown 42 forms an angle A4 preferably within the range of 5° to 30° and preferably about 16°. The inner wall 17' of the countersink 18' forms an angle A6 which is greater than 10° and about 13°. The width W1 of the countersink at the bottom between the inner wall 17' and the outer wall 24' is less than .040 inch and preferably about .024 inch. The radius R8 of the curved inner panel wall 16' is substantially greater than the width W1 of the countersink 18' and is about .049 inch.

[0029] The crown 42' of the shell 10' has a height C1 within the range of .075 inch to .095 inch and preferably about .082 inch and a height C2 within the range of .120 inch and .170 inch and preferably about .153 inch. The overall diameter D8 of the shell 10' is about 2.337 inch, and the diameter D7 to the junction 46' is about 2.036 inch. The inner bottom diameter D6 of the outer countersink wall 24' is about 1.910 inch, and the difference W2 between D7 and D6 is greater than the countersink width W1, or about .063 inch. The diameter D9 for the center of the radius R8 is about 1.731 inch. It is understood that if a different diameter shell is desired, the diameters D6-D9 vary proportionately. The height H5 of the center panel 12' above the bottom of the countersink 18' is within the range of .070 inch and .110 inch and preferably about .078 inch. The height H6 of the shell 10' between the top of the center panel 12' and the

top of the crown 42', is within the range of .125 inch and .185 inch, and preferably about .149 inch.

[0030] Referring to FIG. 8, the shell 10' is double-seamed with the upper end portion 48' of a formed can body 50' using tooling substantially the same as described above in connection with FIGS. 3-5 to form a can end 75'. That is, a seamer chuck (not shown), similar to the chuck 55, includes a lower portion similar to the portion 64 which projects into the countersink 18' and has surfaces corresponding to the surfaces 58, 62 and 68 of the seamer chuck 55 for engaging the outer countersink wall 24', the chuckwall portion 32', and for forming the inner wall 74' of the double-seamed crown 70'. As also shown in FIG. 8, the inner wall 74' of the double-seamed crown 70' extends at a slight angle A5 of about 4°, and the overall height H3 of the can end 75' is less than .240 inch and preferably about .235 inch. The height H4 of the double-seamed crown 70' is on the order of .100 inch and the height H7 from the top of the crown 70' to the top of the center panel 12' is greater than the center panel height H5, preferably about .148 inch.

[0031] FIGS. 9 -11 show another embodiment or modification of the invention including a can shell (FIG. 9) wherein the structural components corresponding to the components described above in connection with FIGS. 7 & 8 have the same reference numbers but with the addition of double prime marks. Thus referring to FIG. 9, a can shell 10" has a center axis which is the same as the axis 11 and includes a circular center panel 12" connected to a peripheral curved panel wall 16" which connects with an inclined inner wall 17" of a countersink 18" having a U-shaped cross-sectional configuration. The countersink has a generally cylindrical outer wall 24" which extends at an angle less than 10° and connects with a chuckwall having a frusto-conical upper wall portion 32" and slightly curved lower wall portion 34".

[0032] The wall portions 32" and 34" are connected by a kick or generally vertical or generally cylindrical short riser wall portion 35" having relatively sharp inside and outside radii, for example, on the order of .020 inch. The upper chuckwall portion 32" is connected to an inner wall 38" of a crown 42" having a curved outer wall 44". As shown in FIG. 11, the riser wall portion 35" has a coined outer surface 105 which results in the wall portion 35" having a thickness sightly less than the wall thickness of the adjacent wall portions 32" and 34".

[0033] The inner wall 38" of the crown 42" connects with the upper chuckwall portion 32" at a junction 46", and the outer wall 24" of the countersink

18" connects with the lower chuckwall portion 34" at a junction 47". The vertical height G1 from the bottom of the countersink 18" to the kick or riser wall portion 35" is about .099. The radius R10 is about .100 inch, and the lower wall portion 34" extends at an angle A3 of about 15°. The countersink 18" has an inner radius R9 of about .021 inch and an outer radius R11 of about .016 inch. Other approximate dimensions and angles for the shell 10" shown in FIG. 9 are as follows:

C3	.249 inch	W1	.030 inch	G3	.045 inch
D6	1.900 "	W2	.047 "	G4	.117 "
D8	2.336 "	W3	.043 "	H5	.081 "
D9	1.722 "	A2	.29°	R8	.051 "
		A6	.8°		

[0034] The particular cross-sectional configuration of the can shell 10" has been found to provide performance results somewhat superior to the performance results provided by the can shell 10'. Accordingly, the details of the configuration of the can shell 10" include a chuckwall upper wall portion 32" having an angle A2 relative to the center axis of at least 16° and preferably within the range of 25° to 30°. The lower wall portion 34" of the chuckwall forms an angle A3 which is about 15°. The inner wall 17" of the countersink 18" forms and angle A6 which is less than 10° and about 8°. The width W1 of the countersink at the bottom between the inner wall 17" and the outer wall 24" is less than .040 inch and preferably about .030 inch. The radius R8 of the curved inner panel wall 16" is substantially greater than the width W1 of the countersink 18" and is about .051 inch.

[0035] The crown 42" of the shell 10" has a height C3 from the bottom of the countersink 18" of about .249 inch. The overall diameter D8 of the shell 10" is about 2.336 inch. The inner bottom diameter D6 of the outer countersink wall 24" is about 1.900 inch, and the difference in diameter W2 is greater than the countersink width W1, or about .047 inch. The diameter D9 for the center of the radius R8 is about 1.722 inch. It is understood that if a different diameter shell is desired, the diameters D6, D8 & D9 vary proportionately. The height H5 of the center panel 12" above the bottom of the countersink 18" is preferably about .081 inch. As shown in FIG. 9, the curved panel wall 16" has a coined portion 107 with a thickness less than the thickness of the adjacent portions of the panel wall 16".

[0036] FIG. 12 shows another embodiment or modification of the invention and wherein a can shell 110 has structural components corresponding to the components described above in connection with FIGS. 7-9 and having the same reference numbers as used in FIG. 9 but with the addition of "100". Thus referring to FIG. 12, the can shell 110 has a center axis which is the same as the axis 11 and includes a center panel 112 connected to a peripherally curved panel wall 116 which connects directly with an inclined inner wall 117 of a countersink 118 having a U-shaped cross sectional configuration. Thus there is no straight wall portion between the walls 116 and 117. The countersink has a generally cylindrical outer wall 124 which extends at an angle less than 10° and connects with a chuckwall having a generally frusto-conical upper wall portion 132 and a slightly curved lower wall portion 134.

[0037] The wall portions 132 and 134 are integrally connected by a curved portion 135 resulting in a slightly S-curved configuration formed by radii R10, R12 and R13. The upper chuckwall portion 132 is connected to an inner wall portion 138 of a crown 142 having a curved outer wall 144. The inner wall 138 of the crown 142 connects with the upper chuckwall portion 132 at a first junction 146, and the outer wall portion 124 of the countersink 118 connects with the lower chuckwall portion 134 at a second junction 147.

[0038] The approximate dimensions and angles for the shell 110 shown in FIG. 12 are as follows:

C3	.246 inch	W1	.030 inch	R8	.050	G1	.091 inch
D6	1.895 "	W2	.042 "	R9	.022	G3	.047 "
D8	2.335 "	W3	.043 "	R10	.054	G4	.101 "
D9	1.718 "	A2	29°	R11	.009	H5	.082 "
		A3	15°	R12	.031		
		A7	42°	R13	.190		

[0039] The cross-sectional configuration of the can shell 110 having the above dimensions and angles has been found to provide performance results slightly superior to the performance results provided by the can shell 10' and 10". The added benefits of the angular or inclined inner countersink wall 117 is set forth in above mentioned Patent No. 5,685,189, the disclosure of which is incorporated by reference. In addition, the above statements and advantages of the can shell 10' and 10" also apply to the can shell 110 shown in FIG. 12.

[0040] By forming a shell and can end with the configuration and dimension described above, it has been found that the can end may be formed

from aluminum sheet having a thickness of about .0082 inch and which will withstand a pressure within the can of over 110 psi before the can end will buckle. The configuration and relative shallow profile of the can shell also result in a can end having an overall height of less than .240 inch, thus providing for a significant reduction of over .040 inch in the diameter of the circular blank which is used to form the shell. This reduction in diameter results in a significant reduction in the width of aluminum sheet or web used to produce the shells, thus a reduction in the weight and cost of aluminum to form can ends, which is especially important in view of the large volume of can ends produced each year.

[0041] The shell of the invention also minimizes the modifications required in the tooling existing in the field for forming the double-seamed crown 70 or 70' or double-seaming the crown 42" or 142. That is, the only required modification in the tooling for forming the double-seamed crown is the replacement of a conventional or standard double-seaming chuck with a new chuck having the frusto-conical mating surface 62 and the generally cylindrical surface 68 on the bottom portion 64 which extends into the countersink and engages the outer countersink wall. Conventional double-seaming chucks commonly have the slightly tapered surface 58 which extends at an angle of about 4° with respect to the center axis of the double-seaming chuck. As also apparent from FIG.10, the slight S-curve configuration of the intermediate portion of the chuckwall of the shell provides for stacking the shells in closely nested relation in addition to increasing the buckle strength of the can end formed from the shell.

[0042] While the forms of can shell and can end herein described and the method of forming the shell and can end constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of can shell and can end, and that changes may be made therein without departing from the scope and spirit of the invention as defined in the appended claims.

[0043] What is claimed is: